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I. FORCED MOVEMENTS, TROPISMS, AND ANIMAL CONDUCT

Dr. Loeb is chairman of the board of editors which is issuing a series of monographs on experimental biology and general physiology. These monographs which collectively cover a wide field are designed to encourage quantitative experimental work as against descriptive and speculative; and to this end each one presents a summary of the exact work that has already been done in its particular field.

Dr. Loeb introduces the series with a volume treating forced movements and tropisms in relation to animal conduct. His analysis is designed to illustrate the application of the quantitative method to the study of animal behavior. He holds that such study supports his own well-known theory of tropisms or forced movements. This hypothesis, first propounded by him some thirty years ago, is in antithesis to the more anthropomorphic idea that animal behavior is the result of trial and error, of pleasure and pain, of curiosity or other internal physiological states.

In Chapter II the author, in a most suggestive and lucid way, shows how the fundamental symmetry of animals is the starting point and foundation for an exact analysis of behavior. The importance of animal symmetry lies in the fact that the morphological plane of symmetry is also the dynamical plane of symmetry. This morphological symmetry is the gross expression of equivalency of chemical constitution and of reacting stuffs, and this gives a basis for quantitative and comparative experiments involving the similar elements both of reception and response.

To illustrate by a quotation: "When symmetrical elements of the eyes are struck by light of the same wave length and intensity, the velocity of photochemical reactions will be the same in both eyes. Symmetrical spots of the retina are connected with symmetrical elements in the brain and these in turn with symmetrical muscles. As a consequence of the equal photochemical reactions in the symmetrical spots of the retina, equal changes are produced in the symmetrical brain cells with which they are connected, and equal changes in tension will be produced in the symmetrical muscles on both sides of the body with which the active brain elements are connected. On account of the symmetrical character of all the changes no deviation from the original direction of motion will

occur. If, however, one eye is illuminated more than the other eye, the influence upon the tension of symmetrical muscles will no longer be the same and the animal will be forced to deviate from the original direction of motion." The bilaterally symmetrical organism serves as a kind of pair of physiological scales or balances, by which one may appraise the forces causing movement. Couple this with the asymmetrical polarity of head end and tail end (or free end and base) and one can anticipate the general method of the book. But no one can anticipate the brilliant and vivid illustrative experiments and the special interpretations of these in the support of the general hypothesis.

In Chapter three on "Forced Movements," the author illustrates three kinds of forced movements: circus motions (involving some destruction of symmetry of tension), the tendency to go backward, and the tendency to move forward. These latter movements are related to the antero-posterior polarity.

In the remaining chapters the author gives experiments and their interpretation under the following heads: Galvanotropism, Heliotropism, Geotropism, Rheotropism, Anemotropism, Stereotropism, Chemotropism, and Thermotropism. Except in the case of the first of these a large part of the account is of new experiments.

A relatively large part of the book is given to the discussion of heliotropism. There are special chapters dealing with particular problems involved in heliotropism, as: light of different intensity from double sources; the Bunsen-Roscoe law for heliotropic reactions; effect of rapid changes in intensity of light; relative effectiveness of different wave lengths; charges or reversals of heliotropism.

The concluding chapters XVIII and XIX deal with instinct and memory images in relation to the theory of forced movements. This the author rightly states is the real test of the theory. While suggestive, these are the least convincing and satisfactory chapters of the book.

Instincts are tropistic reactions modified by hormones,—or otherwise. A quoted example will give the author's method. "The fact that eggs are laid by insects on material which serves as a nutrient medium for the offspring is a typical instinct. An experimental analysis shows that the underlying mechanism of the instinct is a positive chemotropism of the mother insect for the type of substance

serving her as food; and when the intensity of these volatile substances is very high, i.e. when the insect is on the material, the egg-laying mechanism of the fly is automatically set in motion. Thus the common house-fly will deposit its eggs on decaying meat but not on fat; but it will deposit it on objects smeared over with assa-foetida, on which the larvae cannot live. It seems that the female insect lays her eggs on material for which she is positively chemotropic, and this is generally material which she also eats. The fact that such material serves as food for the coming generation is an accident. Considered in this way, the mystic aspect of the care of insects for the future generation is replaced by the simple mechanistic conception of a tropistic reaction."

The author's treatment of memory images and the general phenomena of association seem to indicate a negative psychiotropism on his part which results in "forced" conclusions.

It is not often, in spite of his mechanistic determinism, that the author's logic actually nods. But surely the fact that "Passenger pigeons when reared by ring doves refuse to mate with their own species but mate with the species of their foster parents" does *not* "show incidentally that racial antagonism is not inherited but acquired." The most that it can "show" is that if inherited in any degree such aversion can be lost thru experience.

The book is wonderfully suggestive and is a strong exposition of the purely mechanist thesis.

Monographs on Experimental Biology: Volume I, Forced Movements, Tropisms, and Animal Conduct, by Jacques Loeb. 210 pages, illustrated. J. B. Lippincott and Company, Philadelphia. 1918. Price \$2.50.

II. THE ELEMENTARY NERVOUS SYSTEM

This is the second in the series of volumes summarizing the results in various special fields of experimental physiology. It is written with the directness and clearness characteristic of Professor Parker's writings.

"Elementary" in this title is used in a strict sense, as the author confines his discussion to the conditions found in the three simpler phyla of multicellular animals,—the sponges, coelenterates, and ctenophores.